## Contents

Chapter I		Preliminaries on Categories,	1
	£ 1	Abelian Groups, and Homotopy	1 1
	-	Categories and Functors	1
	8 2	Abelian Groups (Exactness, Direct Sums, Free Abelian Groups)	7
	§ 3	Homotopy	13
Chapter II		Homology of Complexes	16
	§ 1	Complexes	16
	§ 2	Connecting Homomorphism,	
	_	Exact Homology Sequence	19
	§ 3	Chain-Homotopy	23
	§ 4	Free Complexes	26
Chapter III		Singular Homology	29
	§ 1	Standard Simplices and Their Linear Maps	29
	§ 2	The Singular Complex	30
	§ 3	Singular Homology	32
	§ 4	Special Cases	33
	§ 5	Invariance under Homotopy	37
	§ 6	Barycentric Subdivision	40
	§ 7	Small Simplices. Excision	43
	§ 8	Mayer-Vietoris Sequences	47
Chapter IV		Applications to Euclidean Space	54
	§ 1	Standard Maps between Cells and Spheres	54
	§ 2	Homology of Cells and Spheres	55
	§ 3	Local Homology	59
	§ 4	The Degree of a Map	62
	§ 5	Local Degrees	66
	§ 6	Homology Properties	
		of Neighborhood Retracts in IR"	71



X Contents

	-	Jordan Theorem, Invariance of Domain Euclidean Neighborhood Retracts (ENRs)	78 79
Chapter V		Cellular Decomposition	
		and Cellular Homology	85
		Cellular Spaces	85
		CW-Spaces	88
		Examples	95
		Homology Properties of CW-Spaces	101
		The Euler-Poincaré Characteristic	104
	§ 6	Description of Cellular Chain Maps and	
	0.77	of the Cellular Boundary Homomorphism	106
		Simplicial Spaces	111
	§ 8	Simplicial Homology	119
Chapter VI		Functors of Complexes	123
	§ 1	Modules	123
	§ 2	Additive Functors	127
		Derived Functors	132
	§ 4	Universal Coefficient Formula	136
	§ 5	Tensor and Torsion Products	140
	§ 6	Hom and Ext	146
	§ 7	Singular Homology and Cohomology	
		with General Coefficient Groups	150
	§ 8	Tensorproduct and Bilinearity	157
	§ 9	Tensorproduct of Complexes.	
		Künneth Formula	161
§	10	Hom of Complexes.	
		Homotopy Classification of Chain Maps	167
§	11	Acyclic Models	174
§	12	The Eilenberg-Zilber Theorem.	
		Künneth Formulas for Spaces	178
Chapter VII		Products	186
	8 1	The Scalar Product	187
		The Exterior Homology Product	189
	-	The Interior Homology Product	
	3 -	(Pontrjagin Product)	193
	δ4	Intersection Numbers in $\mathbb{R}^n$	197
	•	The Fixed Point Index	202
	-	The Lefschetz-Hopf Fixed Point	
		Theorem	207
	8 7	The Exterior Cohomology Product	214

XI

	§ 8	The Interior Cohomology Product	
	·	(~-Product)	219
	§ 9	-Products in Projective Spaces.	
	v	Hopf Maps and Hopf Invariant	222
	§ 10	Hopf Algebras	227
	-	The Cohomology Slant Product	233
		The Cap-Product (~-Product)	238
		The Homology Slant Product,	
		and the Pontrjagin Slant Product	245
Chapter VIII		Manifolds	247
	§ 1	Elementary Properties of Manifolds	247
	§ 2	The Orientation Bundle of a Manifold	251
	§ 3	Homology of Dimension $\geq n$	
		in n-Manifolds	259
	§ 4	Fundamental Class and Degree	266
	§ 5	Limits	272
	§ 6	Čech Cohomology	
		of Locally Compact Subsets of R"	281
	§ 7	Poincaré-Lefschetz Duality	291
	§ 8	Examples, Applications	298
	§ 9	Duality in ∂-Manifolds	303
	§ 10	Transfer	308
	§ 11	Thom Class, Thom Isomorphism	314
	§ 12	The Gysin Sequence. Examples	325
	§ 13	Intersection of Homology Classes	335
Appendix		Kan- and Čech-Extensions of Functors	348
	§ 1	Limits of Functors	348
	§ 2	Polyhedrons under a Space,	
		and Partitions of Unity	352
	§ 3	Extending Functors from Polyhedrons	
		to more General Spaces	361
		Bibliography	368
		Subject Index	371